

# A Research Reactor Concept To Support NTP Development

Michael Eades (The Ohio State University) [eades.15@osu.edu](mailto:eades.15@osu.edu)

Thomas Blue (The Ohio State University) [blue.1.@osu.edu](mailto:blue.1.@osu.edu)

Harold Gerrish (NASA) [harold.p.gerrish@nasa.gov](mailto:harold.p.gerrish@nasa.gov)

Leroy Hardin (US NRC) [leroy.hardin@nrc.gov](mailto:leroy.hardin@nrc.gov)

## Nuclear and Emerging Technology for Space

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# Introduction

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## Ultimate NASA Goal

Development of a Man-Rated NTR Engine

## Path Forward

Build On Past Development Work/Effort

“Don’t Reinvent the Wheel”

Continue Work With Excellent Existing Resources and Partners

Especially DOE

Build Organic/Internal NASA Capability to Support Research

Complimentary to Existing Resources

Not Replacing

# Introduction (cont)

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## Specific Target Area for This Discussion

Potential NASA Research Reactor

## Specifics

Technical Details Covered Later

Provides Capabilities that are Additive to the Current Research Mix

Also by Teaming with Multiple Partners (Particularly Academic)

Supports Enhanced Research and Educational Opportunities

In Line with Atomic Energy Act

# Regulatory Aspects

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## The Concept Currently Under Discussion

LEU Research Reactor

NASA Site

NASA is Licensee

Significant Benefits

## Primary Regulatory Jurisdiction of NRC

Completely Public Licensing Process

Challenges Due to Uniqueness of Design

This is a New Application for a Research Reactor

It's Been a While

# Status

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## Various Details are Being Discussed

Additional Specifics Required to Proceed “Officially”

## NASA Has Initiated Discussions

“Drop-In” Basis

## Next Steps

Pre-Application Discussions

Public Meetings

NRC Review Scheduling

Application Submission

**If** the Decision is Made to Proceed

# Status (cont)

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## More Next Steps

Scheduling Support for Review

Advance Planning Year(s) Prior

Review

Public Meetings

Closed Portions Allowed

Duration

Safely Say More than 1 FY

# Summary

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Potential Research Reactor

Additive Capability to Research Mix

NASA Site

NRC Licensing

Anticipate Engagement of All Current NASA Partners in NTR Effort

In Particular Continued Extensive DOE Engagement and Support

Simply a Continuation of the Successful Working Relationship between  
NASA and DOE

Significant University Involvement/Support

Industry Support

# Bottom Line

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This is just one possible path to support the development effort for NTRs.

And the research reactor being considered could be one of the tipping points in achieving complete success.

But the success of the NTR effort will require all segments (government, academic and corporate) to continue working together for the common good and a common goal.

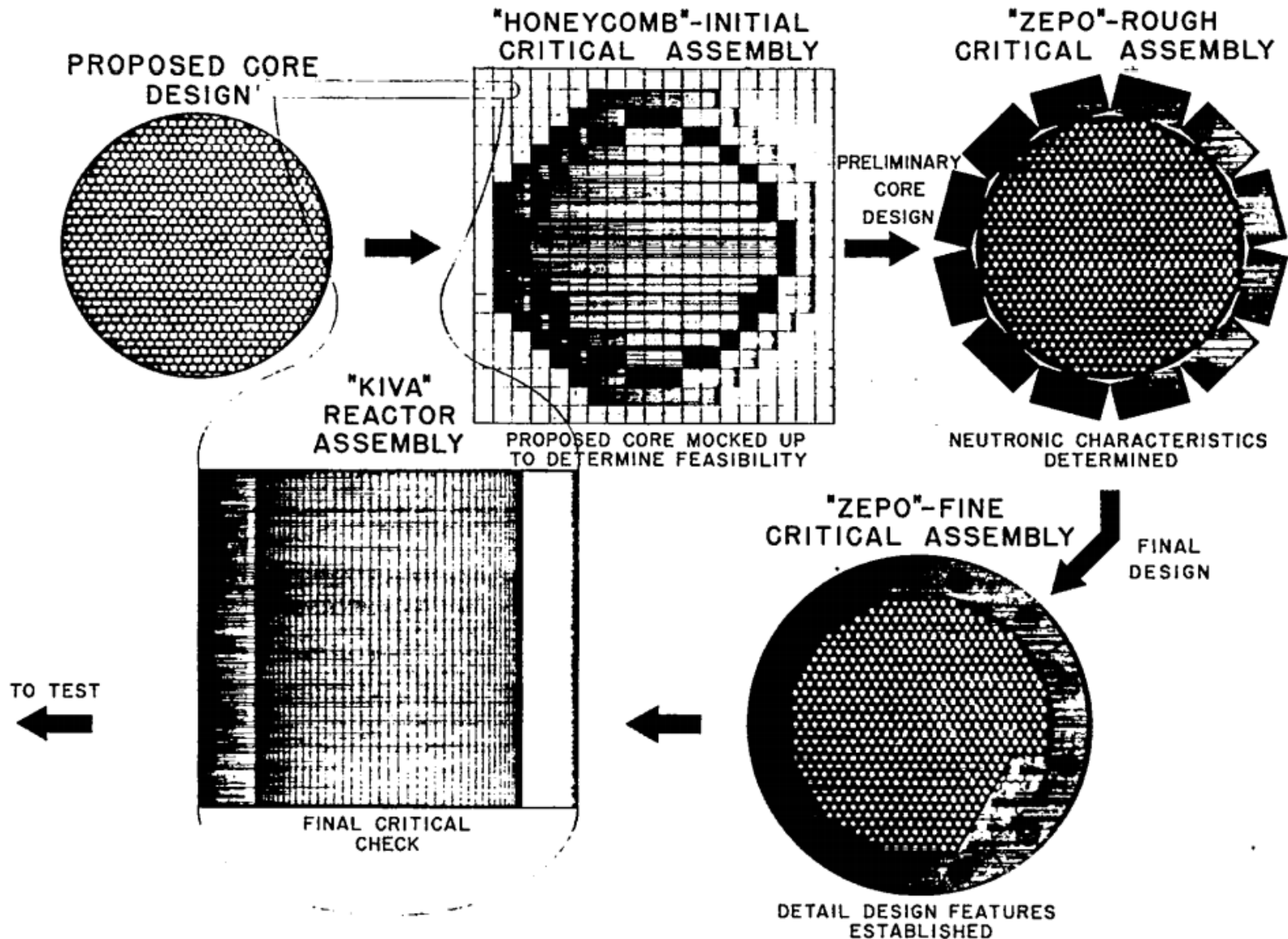
We have to remember that NTR technology is (just) one of the potential game changers for the exploration and commercialization of space.

There can be no vested interests here – we are all on the same side. There are no star players – we must function as a team. That is how we succeed.

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# Technical Discussion

# In the NERVA Program



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Back then...

Nuclear research was cheaper

Computer models were less rigorous

Regulation was less stringent

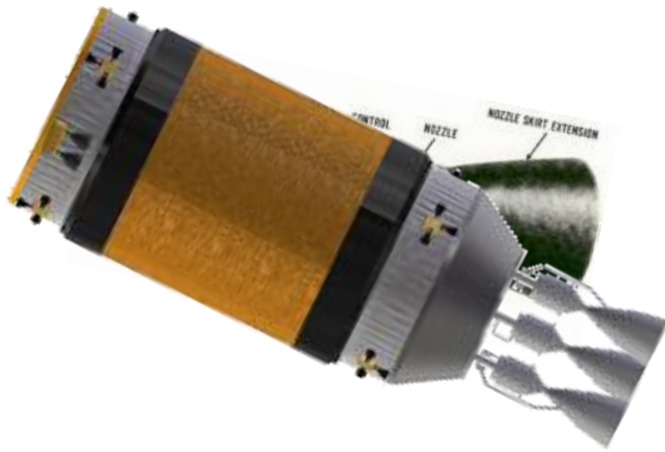
# Overview

## Proposed:

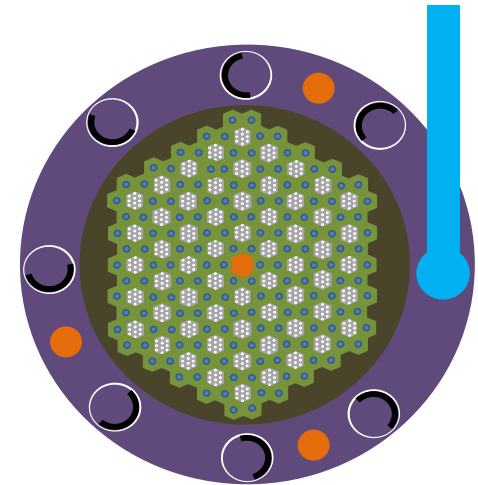
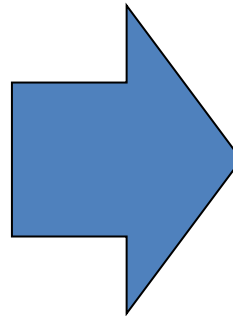
A NRC regulated reactor to act as a milestone to a full ground test.

Complementary to the nation's existing facilities

## Nuclear Thermal Propulsion Research Reactor (NTPRR)



NTP Concept

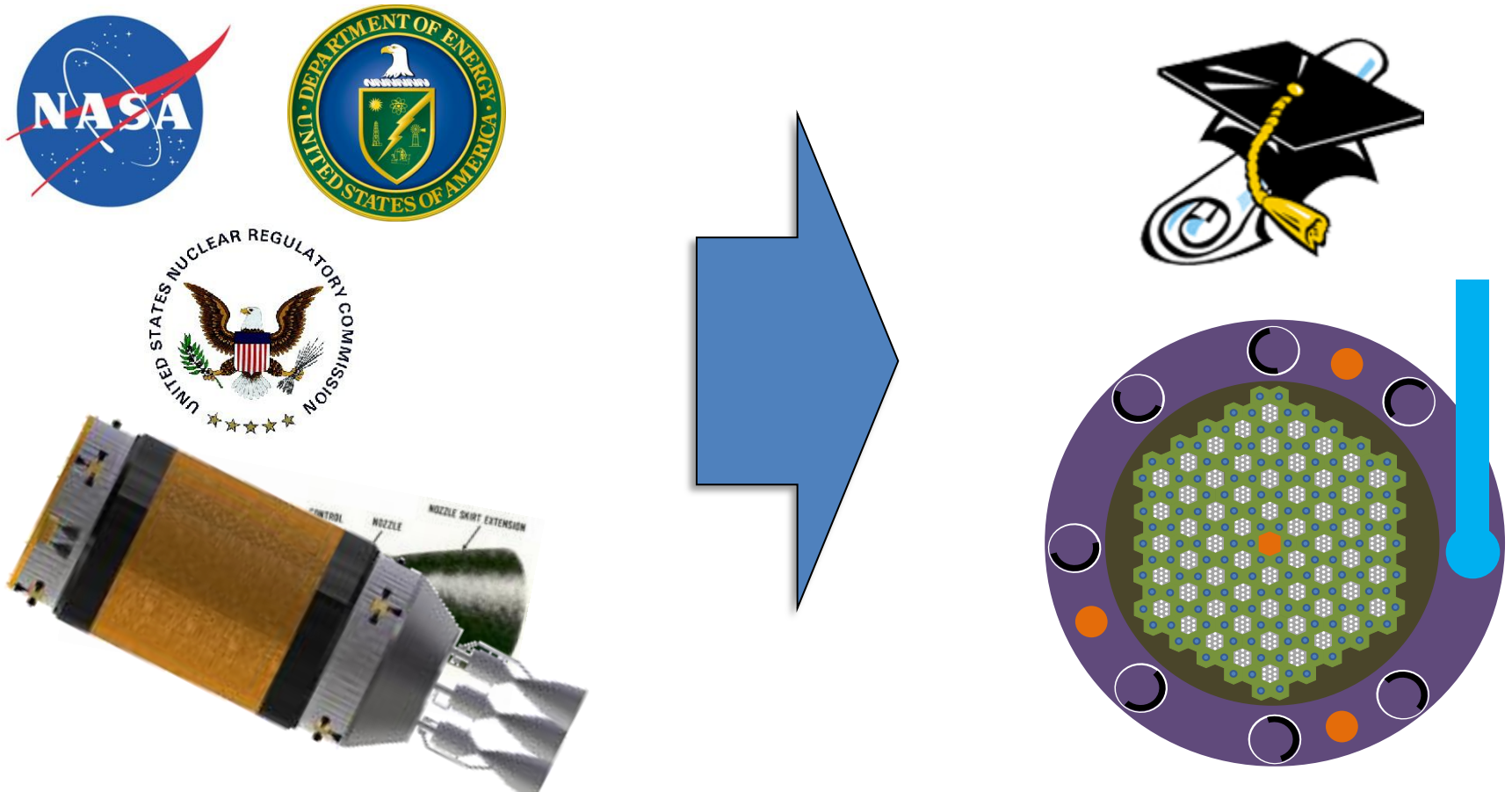


NTPRR

# Overview

## 2 Stakeholders

### NTP Development and Spinoff Applications



# Stakeholders

NTR Development Support



**Builds expertise at test site and working with regulators**

Benchmark for codes

Provides a characteristic NTR environment for materials and fuel testing.

Relatively low cost fission heat milestone

Utilize existing regulatory structures

# Potential Research Reactor Concept

10 MW

Tungsten-UO<sub>2</sub> Cermet LEU fuel

Gas cooled

ZrH<sub>1.8</sub> moderated

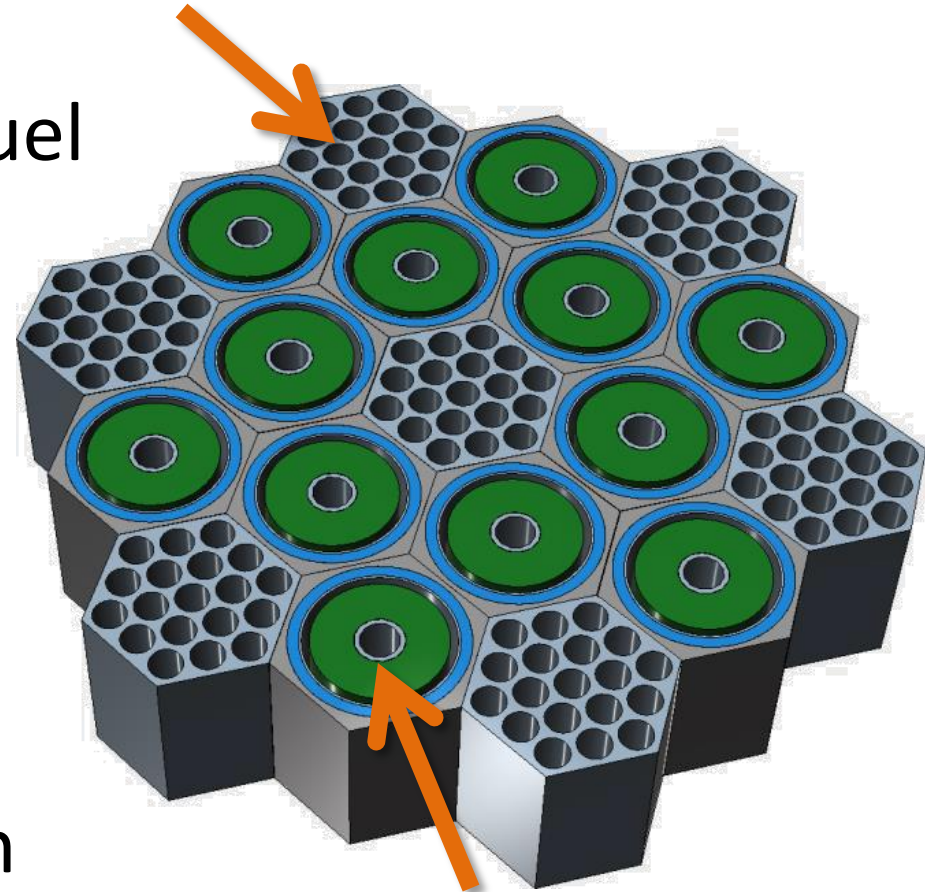
Beryllium reflected

Turbine and Compressor

High Temperature Operation

Different fuels and fuel configurations

Fuel Element



Moderator Element

# Spinoff Applications

## Academic Partners



### Why:

**Spread out cost and maximize benefit of investment in a research reactor**

**A NTR research reactor will be a unique tool for the nation**

High temperature operation and hard flux

Radiation damage studies

Fast Neutron Activation Analysis

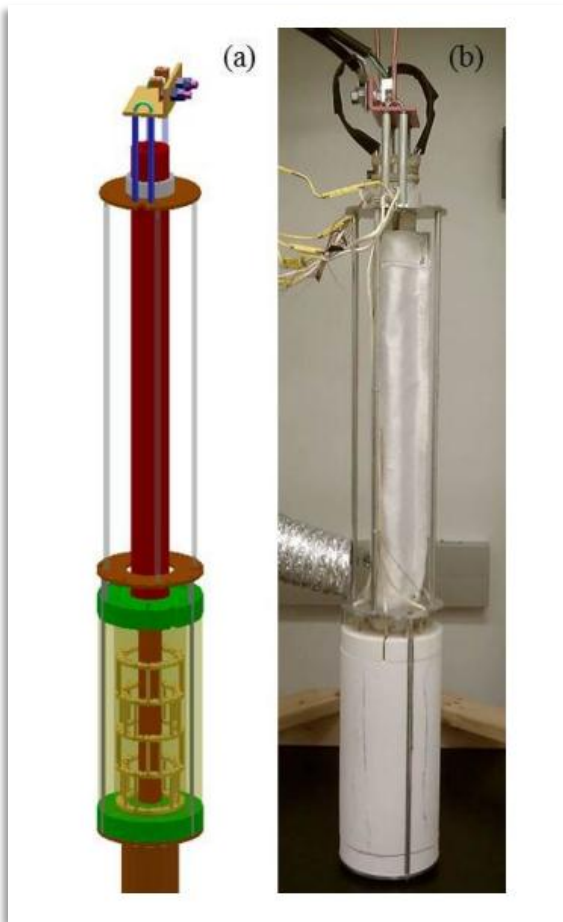
Benchmark Gas Cooled Reactor Codes

Unique Isotope Production

Calibration of fast neutron detectors



# High Temperature



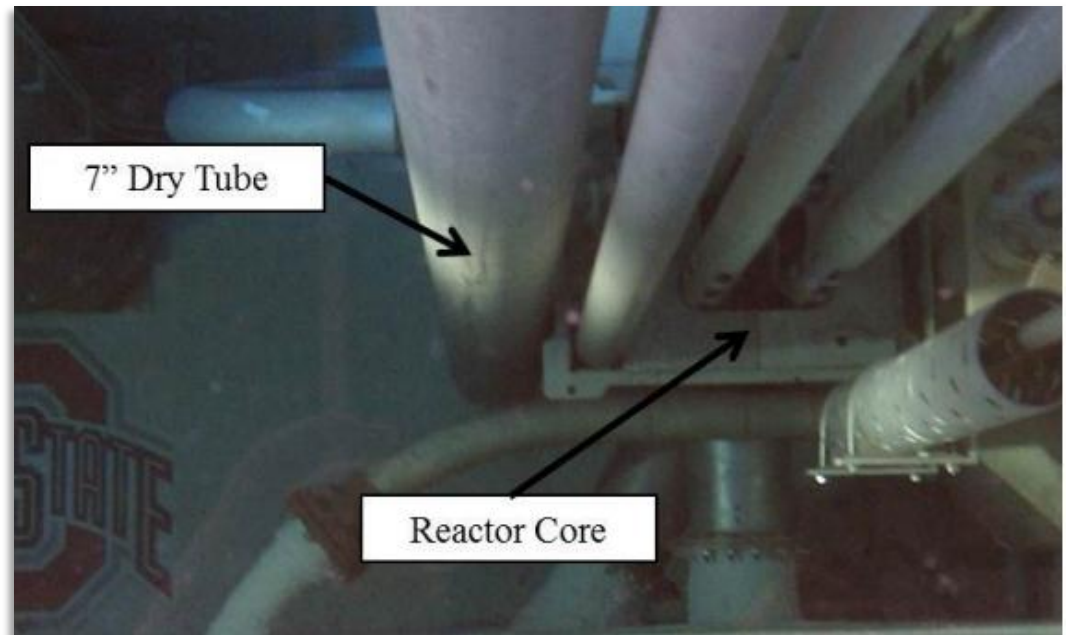
A disposable furnace  
used at the Ohio State  
Research Reactor

## Bulk Exit Temperature

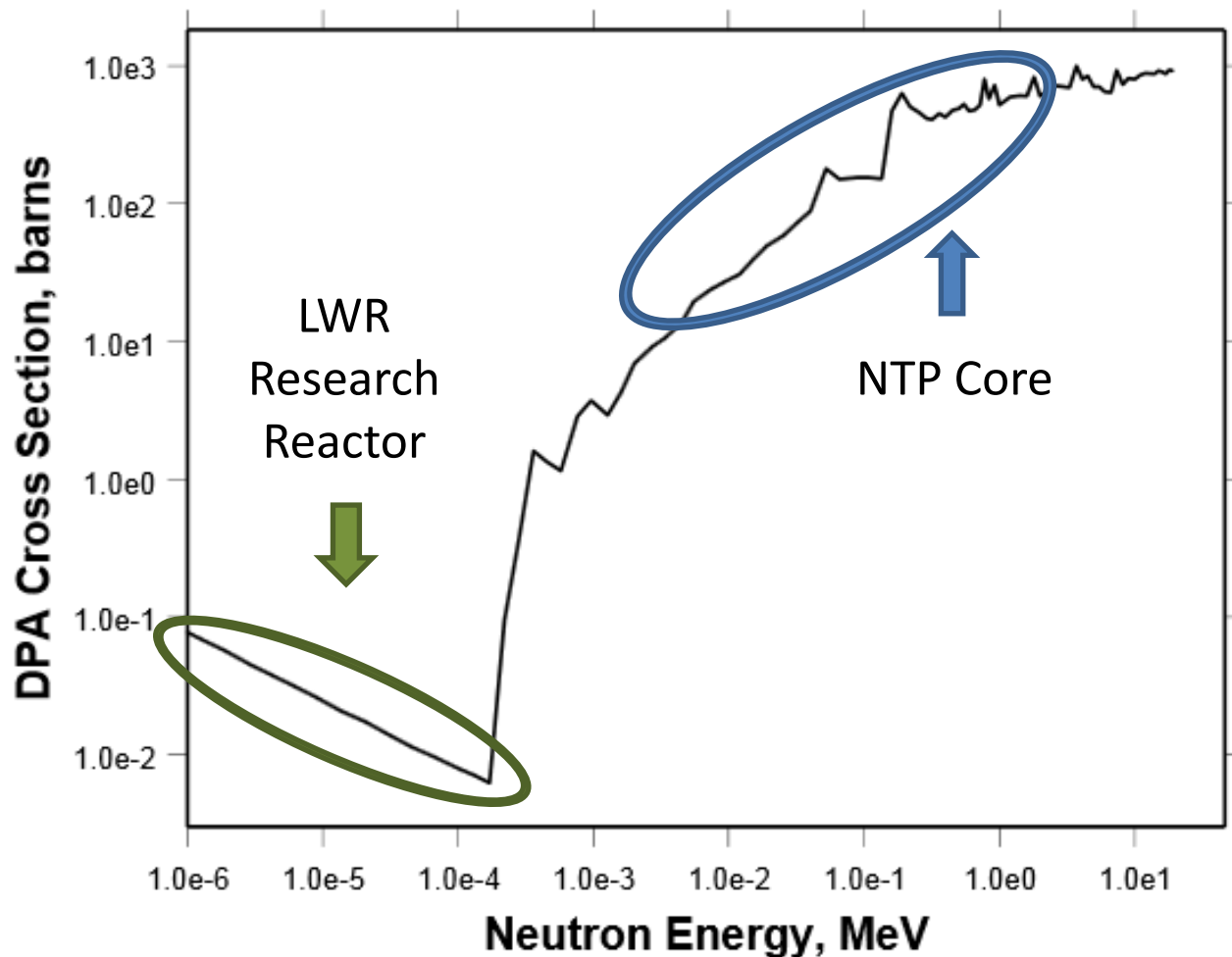
Advanced Test Reactor: 71 °C

High Flux Isotope Reactor: 69°C

NTP core: ~2500 °C

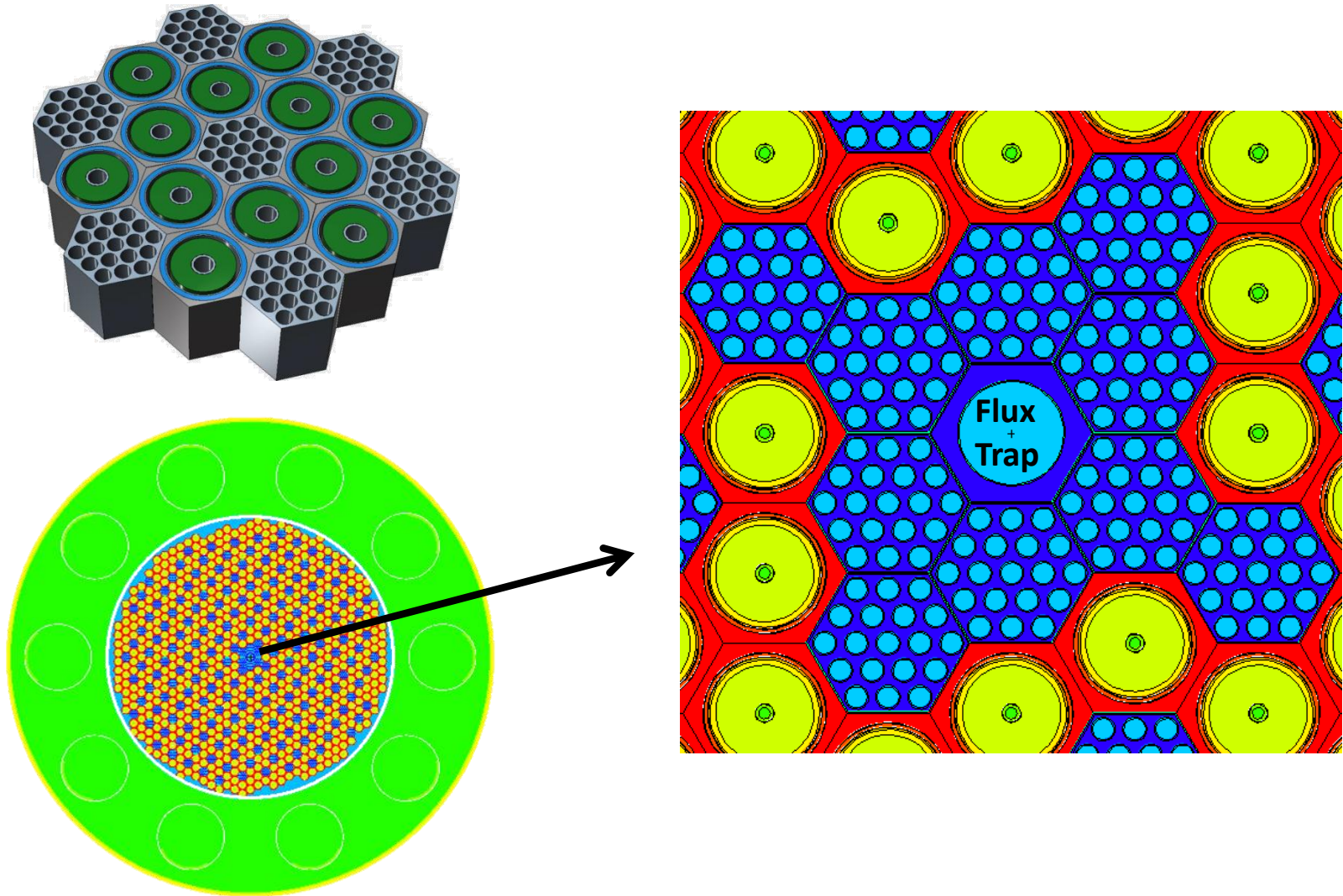


# Harder Spectrum, SiC example



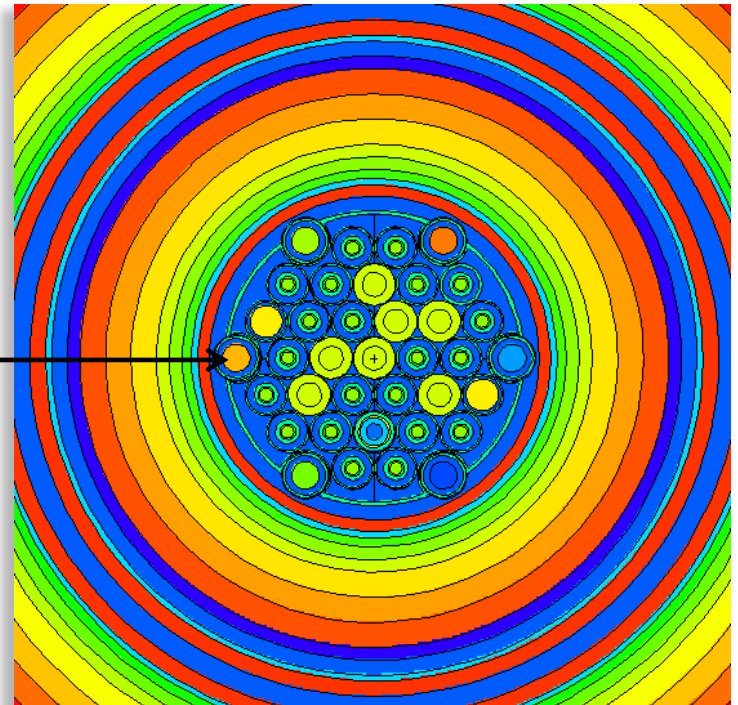
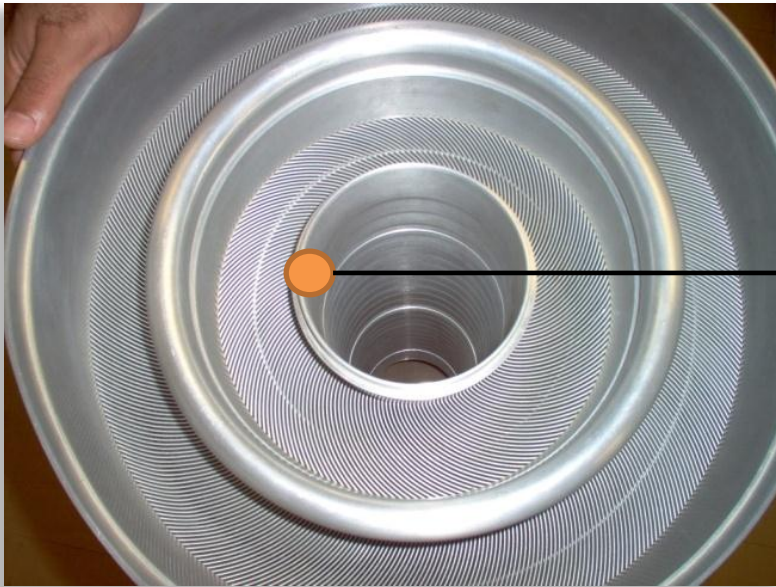
Similar trends can be found all through out radiation damage

# Initial MCNP Results



Unoptimized NTP core Flux Trap

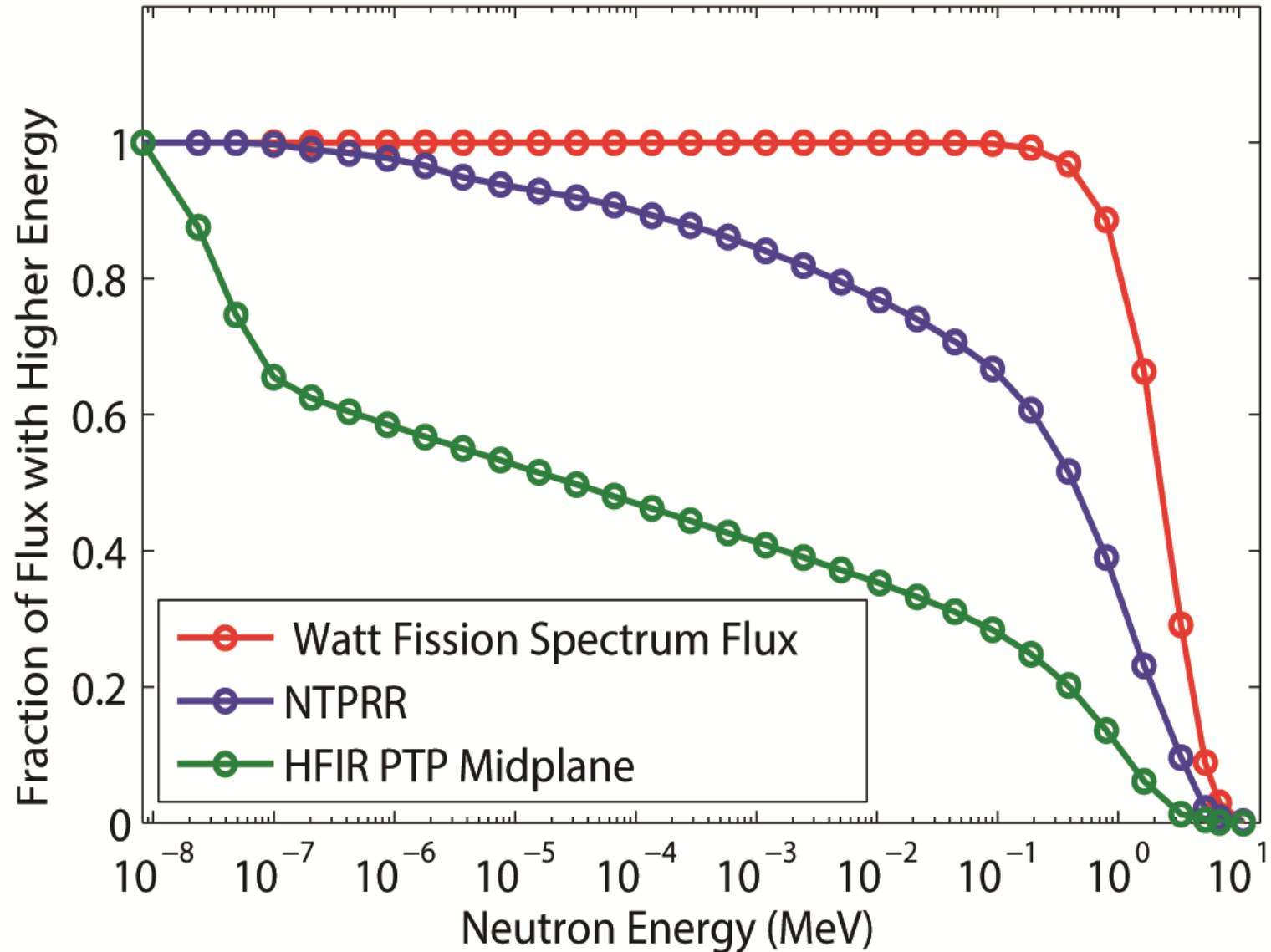
# Initial MCNP Results



## HFIR Peripheral Target Position

-Often used for DPA Studies

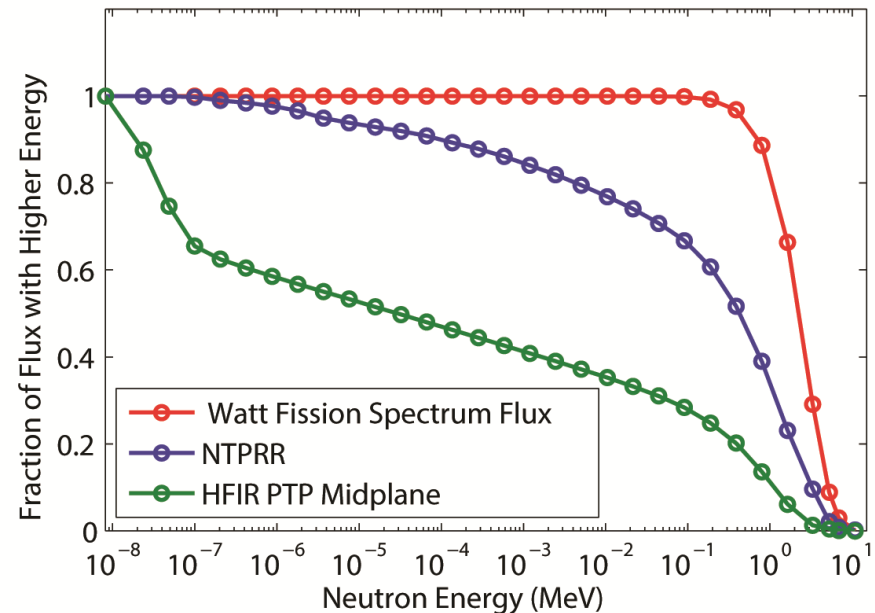
# Unoptimized Initial Results



# Unoptimized Initial Results

NTPRR  $3.3 \times 10^{14}$  at 10 MW,  
~4.2 dpa in SiC per EFPY

HFIR PTP  $3.8 \times 10^{15}$  at 85 MW,  
~28 dpa in SiC per EFPY



First stage irradiations before running an experiment in HFIR or ATR.

Radiation damage studies requiring specialty fluxes and high temperatures.

# Isotope Production

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Fast neutron sources offer unique isotope production capabilities

(n,p) reaction for  $^{32}\text{P}$ ,  $^{33}\text{P}$ ,  $^{35}\text{S}$ ,  $^{57}\text{Co}$ ,  $^{64}\text{Cu}$ ,  $^{67}\text{Cu}$ , and  $^{89}\text{Sr}$

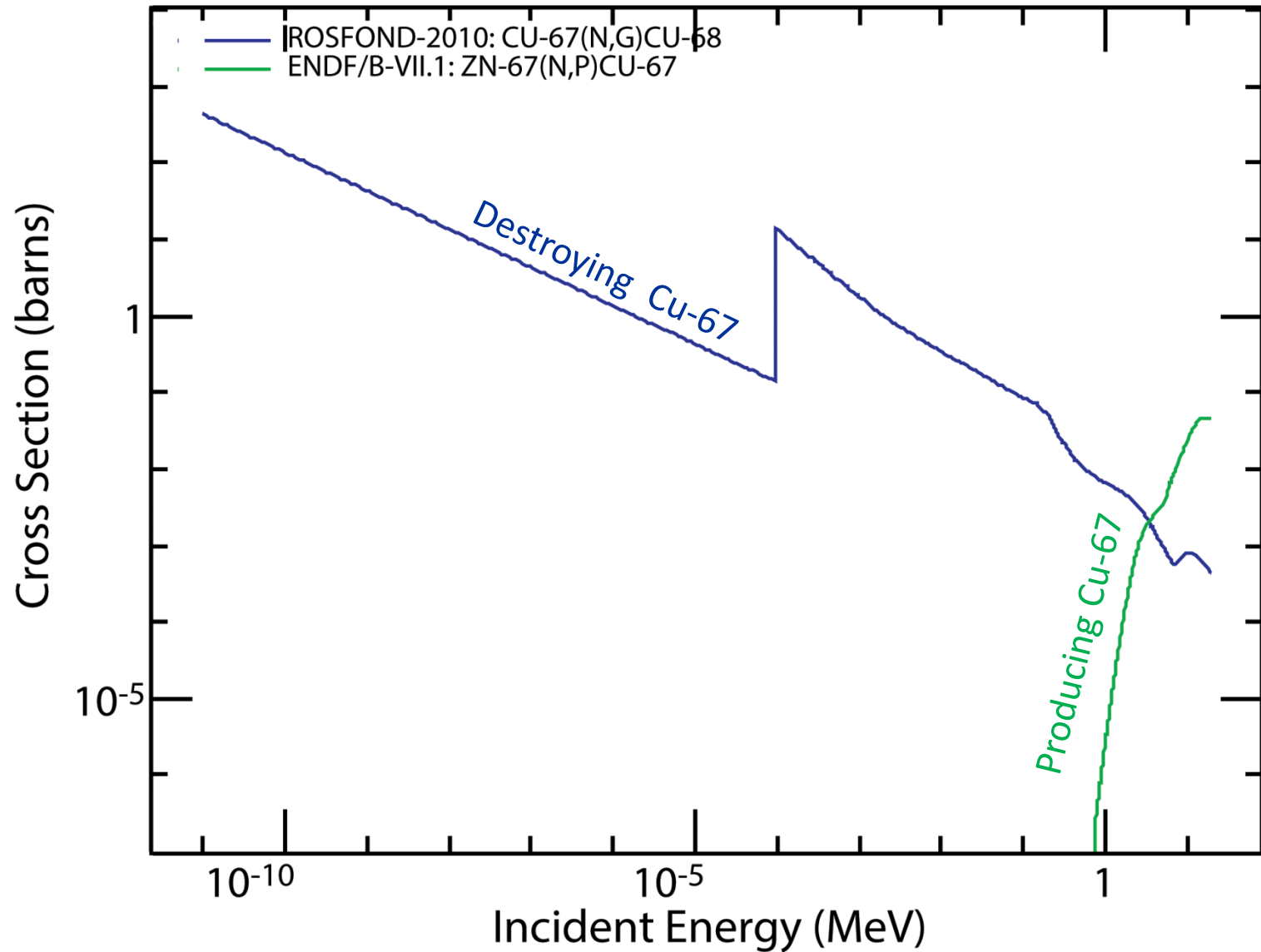
Favorable spectrum for (n, $\gamma$ ) for  $^{127}\text{Xe}$ ,  $^{131}\text{I}$  and  $^{198}\text{Au}$

Fast spectrum Isotope production demonstrated in BR-10

Producing  $^{64}\text{Cu}$  and  $^{67}\text{Cu}$  for medical purposes identified as a research priority Nuclear Science Advisory Committee Isotopes Subcommittee

Often only 1 or 2 suppliers exist for some isotopes

# Cu-67 production from Zn-67



# Summary

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- A NTPRR could play an important role in affordable NTP development.
- A NTPRR would have many spinoff applications and complement the nation's current research reactor capabilities.

# Questions

